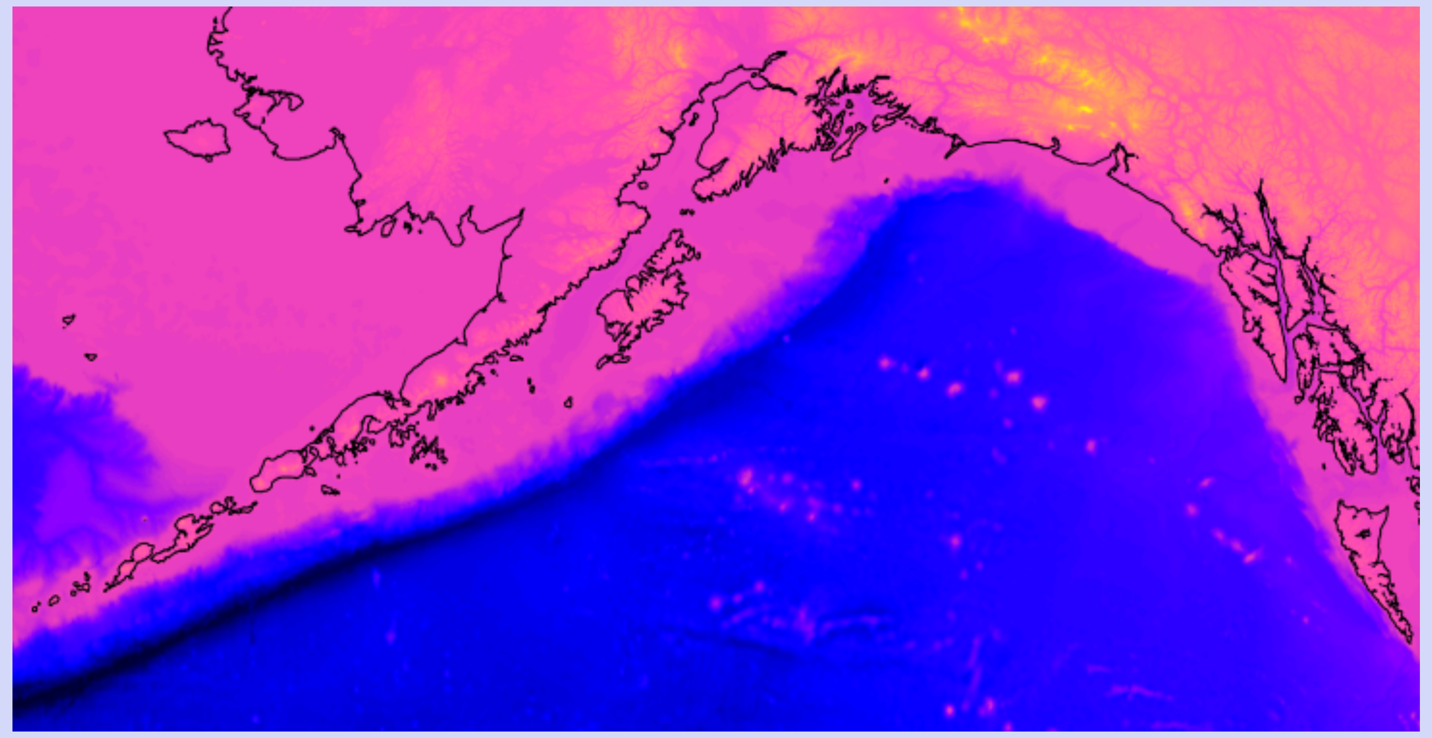
Nonstationarity in spatiotemporal fisheries models

Motivation

- Stationarity assumption
- Complex bathymetry
- Preferences may be complex
- Spatially-varying anisotropy?



Model

$$\Pr(C > 0) = \mathrm{logit}^{-1}\left[z_t\left(\boldsymbol{s}\right)\right]$$

$$\boldsymbol{z}_t = \boldsymbol{X}_\mu \boldsymbol{\beta}_\mu + \boldsymbol{\omega}_t$$

Independent effect by year
Quadratic effect of depth

$$\boldsymbol{\omega}_t \overset{\text{iid}}{\sim} \mathrm{MVN}\left(\boldsymbol{0}, \boldsymbol{Q}^{-1}\right)$$

$$\boldsymbol{Q} = \boldsymbol{T}\left(\boldsymbol{K}^2\boldsymbol{C}\boldsymbol{K}^2 + \boldsymbol{K}^2\boldsymbol{G} + \boldsymbol{G}\boldsymbol{K}^2 + \boldsymbol{G}\boldsymbol{C}^{-1}\boldsymbol{G}\right)\boldsymbol{T}$$

$$\log\left(\boldsymbol{T}_{ii}\right) = \boldsymbol{X}_\tau \boldsymbol{\beta}_\tau$$

Intercept only

$$\log\left(\boldsymbol{K}_{ii}\right) = \boldsymbol{X}_{\kappa^2} \boldsymbol{\beta}_{\kappa^2}$$

Intercept only (stationary)
Linear effect of depth
Quadratic effect of depth

$$\rho(\boldsymbol{s}) = \frac{\sqrt{8}}{\kappa(\boldsymbol{s})} \qquad \sigma(\boldsymbol{s}) = \frac{\tau(\boldsymbol{s})}{2\sqrt{\pi}\kappa(\boldsymbol{s})}$$

Conclusions

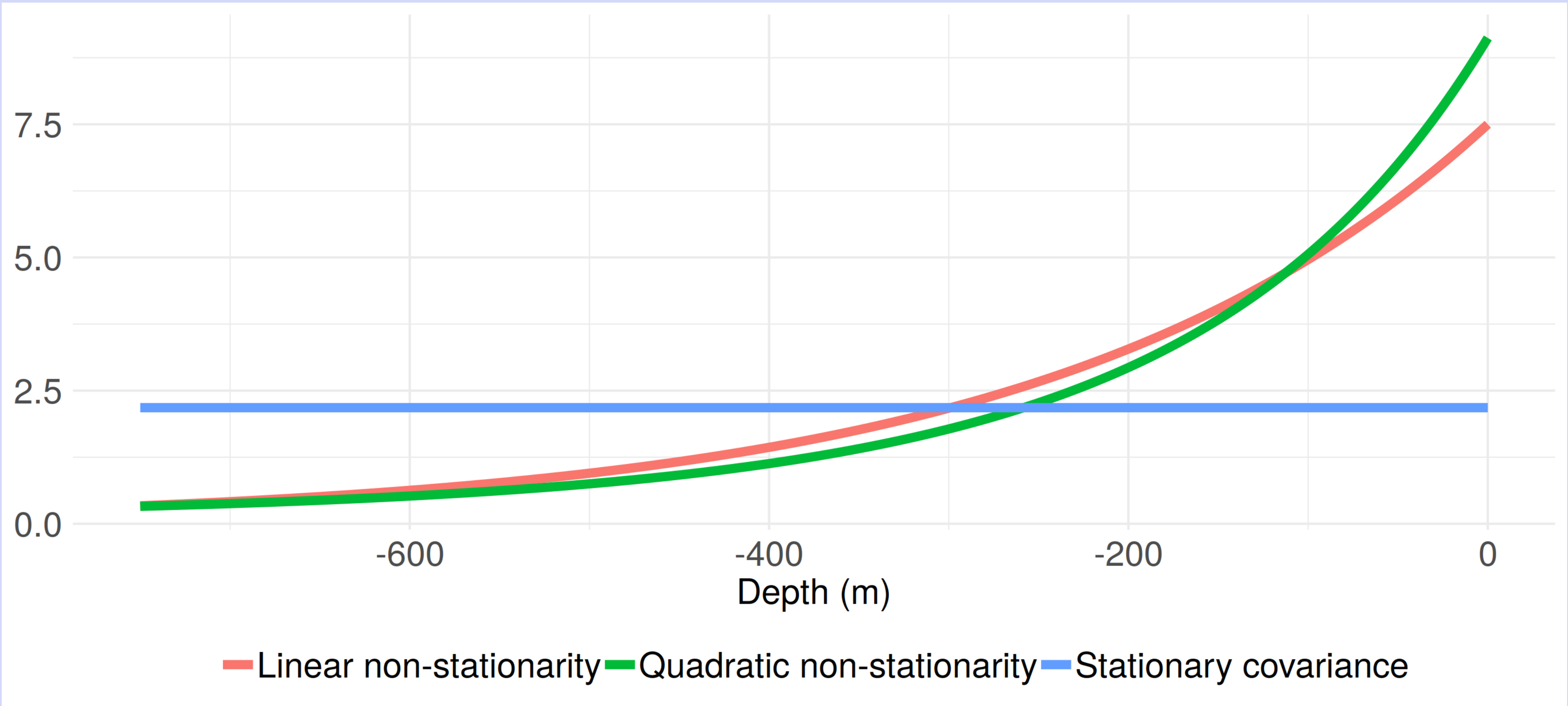
- Possible to parameterize spatially-varying covariance parameters
- Can improve model fit
- Alternative methods for including nonstationarity are worth exploring

References

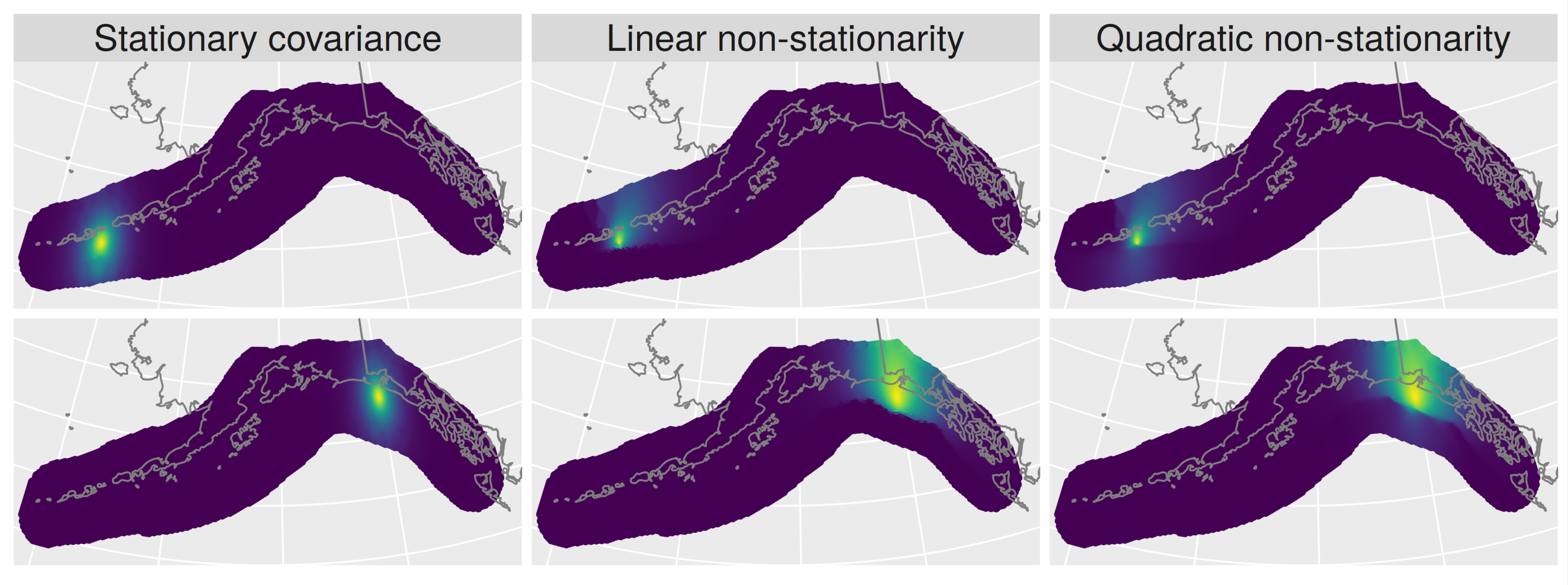
Lindgren, F., Rue, H., & Lindström, J. (2011). An explicit link between gaussian fields and gaussian markov random fields: The stochastic partial differential equation approach. Journal of the Royal Statistical Society. Series B: Statistical Methodology, 73(4), 423–498. https://doi.org/10.1111/j.1467-9868.2011.00777.x

Kristensen, K., Nielsen, A., Berg, C. W., Skaug, H., & Bell, B. (2015). TMB: Automatic Differentiation and Laplace Approximation. https://doi.org/10.18637/jss.v070.i05

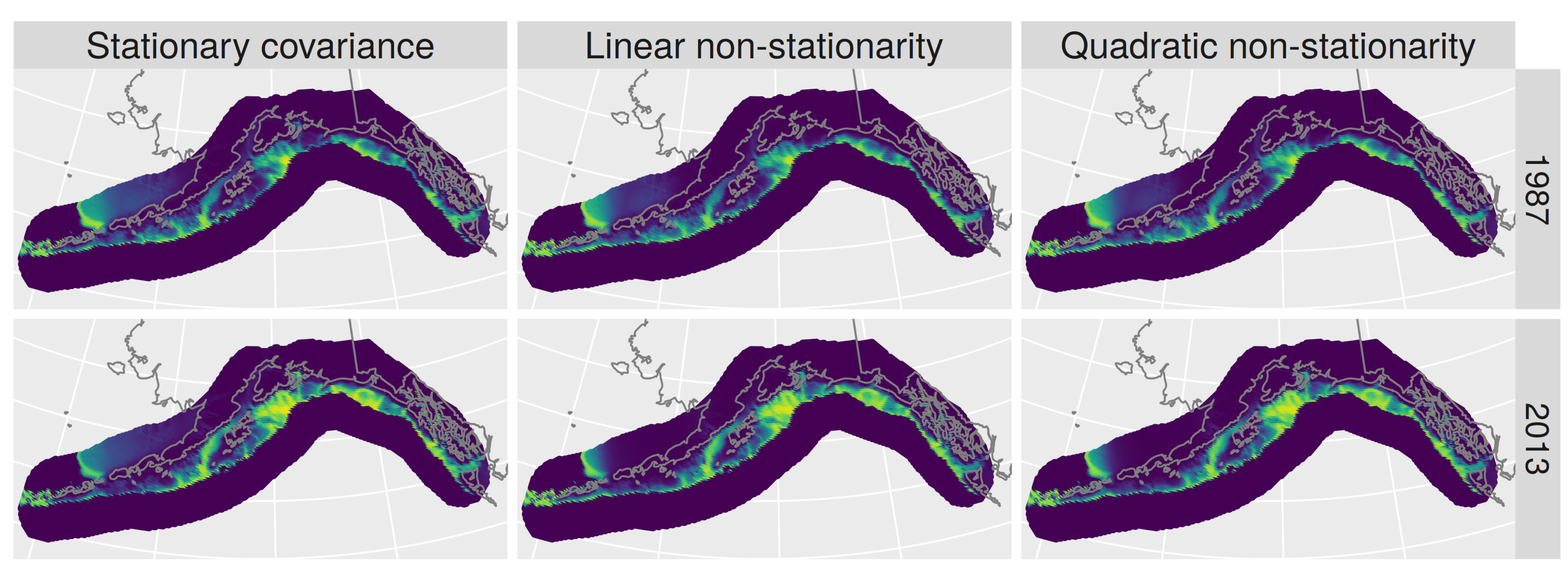
Correlation by depth



Local correlations



Probability of encounter



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